# Conclusions

Even after the known and own ideas of friction and wear of the human and animal synovial joints have been analyzed and extended, it is impossible to explain the nature of their tribological properties. This phenomenon is given rise by the unique and unrecognized mechanism of articulate cartilage lubrication. The numerous data on frictional interaction features received on experimental joint models, of course, are insufficient to understanding the real mechanisms of intraarticular friction decrease in natural conditions. The following conclusion can be drawn from the above analysis.

According to modern views, the cartilage is bi-phase model. A strong porous collagenic framework and mainly sulfated proteoglycan units form its solid phase. Polyanionic nature and the specific structural organization of the last promote cartilage overhydratation and provide its main biomechanical properties: elasticity and shock-absorbing ability. The liquid phase of a cartilage represents low-molecular organic substances and electrolytes in water.

Viscoelastic deformation of a cartilage matrix and pumping out the interstitial liquid in dynamic contact area occur during joint movement. A liquid returns back to a cartilage and its dimension is restored at unloading. In this case, the lubricant layer is formed from components of synovial and interstitial liquids bleeding from cartilage. Joint trophic function is carried out the same way. Efficiency of joint lubrication is promoted also by the main biomechanical property of synovial fluid due to hyalurate, namely, thixotropic behavior pattern, that is ability to be dissolved as gradient of cartilage sliding speed increases.

This standard simple partly explains the mechanisms of cartilage friction decrease at rather fast movements and low nominal pressure in dynamic contact area, but along with this the nature of their boundary lubrication at the low, almost vanishing, sliding speeds and high pressure, remains unclean. It is supposed that in that case there is a formation of monomolecular lubrication layers between the cartilage-conjugated surfaces. Hypotheses of formation layers from hyalurate molecules of a without and with interstitial liquid, a specific lubricant protein —"lubricin" is not sufficiently justified. Joint boundary lubrication is recently assumed to have a compound nature.



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Formation of joint effective layer rubbing down and dividing the cartilage surfaces is tried to be explained with a hypothesis of micropolar liquid.

This the least known division of a biotribology has aroused the most interest and become the primary goal of our research.

Modern achievements in the field of physics of liquid crystals have come into notice. Thanks to them the liquid-crystal state of living systems became a subject of biological investigations in the last decades. There were evidence for effective lubricant action of liquid crystals during solid friction. At the same time, similar data on synovial fluid haven't been found. For this reason, the main body of the book is given over to proofs of a role of cholesteric-nematic liquid crystals in intraarticular friction decrease. This situation was confirmed with results of the physical-chemical analysis of synovial fluid and its components, and also studying of their lubricant properties by numerous research techniques of liquid crystals and liquid-crystal biological media.

A groundbreaking science-based concept of joint cartilage boundary friction became a natural result of this experimental work. It is consistent with known ideas of mechanisms of joint lubrication, and significantly extends and complements knowledge of a biotribology and biophysics of liquid-crystal biosystems. It should be noted that synovial fluid is the complex multicomponent liotropic liquid-crystal media. Therefore lubricating action of a synovial fluid can be realized by the cholesterol esters and cholesteric fatty acids together with proteins, many of which show properties of nematic liquid crystals.

Liotropic liquid-crystal media are least studied today. For that matter the discovery of a liquid-crystal state of the joint synovial fluid has become a new development in biotribology and pathogenetic mechanisms of cartilage destruction during rheumatic afflictions.

The comprehensive description of known understanding of molecular structure, the structural organization and biomechanical features the synovial fluid elements, the analysis of concepts of joint cartilage lubrication and the cause of destruction during trauma and arthropathies, data on efficiency of the existing methods of treatment and prophylaxis of intraarticular damages occupy an important place in the book.

Data on biophysical characteristics of joint cartilages as the rub natural biopolymers will be useful for the material engineer and experts in creation of new composite materials for joint endoprosthesis.

According to D. Dawson, the materials used for joint endoprosthesis possess properties distinct from cartilaginous tissue. That leads to complication of joint replacement.

Creation of materials for endoprosthesis friction couples having comparable characteristics as cartilages and micropolar liquid is the most important endoprosthesis objective. Creation of a new development in arthrology and pharmacotherapy of cartilage destruction during rheumatic afflictions is other essential result of the research work.

The universal and second to none artificial lubricants, having properties of natural synovial fluid, used for both invasive and noninvasive treatment and novel arthropathy therapy have been developed on the basis of the received results.

The experimental data on high chondroprotective efficiency of preparation, checked on osteoarthritis models and during clinical approval, are proof that liquid crystals play an essential role in intraarticular friction decrease. It can be a real prerequisite for development of new pharmaceuticals for cartilage mechanodestruction prophylaxis and therapy during arthropathies.

Summarizing all the aforesaid, authors hope that the their research work will draw attention of arthrology, tribology and biophysics specialists and will serve as a stimulus to further investigation of artificial materials and medias for joints containing liquid crystals.

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